COURSE OUTLINE

COURSE TITLE: INTERNETWORKING: LEVELS 3 AND 4

CBEDS TITLE: TELECOMMUNICATIONS

CBEDS NO.: 4618

JOB TITLES	DOT NO.
Network Support Specialist	
Network Control Technician	
LAN/WAN Technicians	
Network Specialists	
Network Systems Technician	
Cisco Certified Network Technician	

Course Description:
This is the second of two courses designed to provide students with classroom and laboratory experience in current and emerging networking technology that will empower them to enter employment and/or further education and training in the computer networking field. Content standards are based on a task analysis of current industry/occupational standards. The first half of this course includes switches; LAN and virtual local area network (VLAN) design, configuration, and maintenance; internetwork packet exchange (IPX) routing and interior gateway routing protocols (IGRP); and network troubleshooting. The second half of the course includes wide area networks (WANs), integrated services data networks (ISDN), point-to-point protocols (PPP), and frame relay design, configuration, and maintenance. Students develop practical experience in skills related to configuring WANs, ISDN, PPP, and frame relay protocols and network troubleshooting. Integrated throughout the course are career preparation standards, which include basic academic skills, communication, interpersonal skills, problem solving, safety, technology, and other employment skills.

Students receive up to 180 hours of classroom instruction and up to 240 hours of work-based learning at community training sites.

Prerequisites: Internetworking 1 & 2 or the equivalent

2/00

INTERNETWORKING: LEVELS 3 AND 4

COURSE OUTLINE

Upon successful completion of this course, students will be able to demonstrate the following skills necessary for advanced employment.

Additional hours for Career Preparation Standards are integrated into instruction in content area standards.

		Classroom Hours
I.	CAREER PREPARATION STANDARDS	30

A. Understand how personal skill development--including positive attitude, honesty, self-confidence, time management, and other positive traits--affect employability.
   1. Demonstrate an understanding of classroom policies and procedures.
   2. Discuss importance of the following personal skills in the business environment:
      a. positive attitude
      b. self-confidence
      c. honesty
      d. perseverance
      e. self-management/work ethic
      f. pride in product/work
      g. dependability
   3. Identify acceptable business attire.
   4. Establish goals for self-improvement and further education/training.
   5. Prioritize tasks and meet deadlines.
   6. Understand the importance of initiative and leadership.
   7. Understand the importance of lifelong learning in a world of constantly changing technology.

B. Understand principles of effective interpersonal skills, including group dynamics, conflict resolution and negotiation.
   1. Identify and discuss behaviors of an effective team.
   2. Explain the central importance of mutual respect in workplace relations.
   3. Discuss and demonstrate strategies for conflict resolution and negotiation, and explain their importance within the business environment.

4. Understand laws that apply to sexual harassment in the workplace, and identify tactics for handling harassment situations.
5. Work cooperatively, share responsibilities, accept supervision and assume leadership roles.
6. Demonstrate cooperative working relationships and proper etiquette across gender and cultural groups.

C. Understand the importance of good academic skills, critical thinking, and problem-solving skills in the workplace.
   1. Recognize the importance of good academic skills in information technology and implement a plan for self-improvement as needed.
   2. Use mathematical concepts in application of skills, techniques and operations.
      a. mathematical concepts
      b. algebra concepts
      c. binary numbers
      d. additional higher-level math concepts as applicable
   3. Use scientific concepts in application of skills, techniques, and operations.
      a. general science concepts
      b. physical science concepts
      c. additional science concepts (biology, physics, and chemistry, as applicable)
   4. Read, write, and give directions.
   5. Demonstrate skills in technical reading and writing.
   6. Locate information from written and electronic sources, and identify strategies for evaluating their reliability and validity.
   7. Exhibit critical and creative thinking skills and logical reasoning skills, and employ these skills for problem solving.
      a. Work as a team member in solving problems.
      b. Diagnose the problem, its urgency, and its causes.
      c. Identify alternatives and their consequences.
      d. Explore possible solutions.
      e. Compare/contrast the advantages and disadvantages of alternatives.
      f. Determine appropriate action(s).
      g. Implement action(s).
      h. Evaluate results of action(s) taken.

D. Understand principles of effective communication.
   1. Use communication concepts in application of skills, techniques, and operations.
      a. Prepare written material.
      b. Analyze written material.

2. Understand and implement written instructions, from technical manuals, written communications, and reference books.
3. Present a positive image through verbal and nonverbal communication, and understand the power of body language in communication.
4. Demonstrate active listening through oral and written feedback.
5. Give and receive feedback.
6. Demonstrate assertive communications (both oral and written).
7. Demonstrate proper etiquette in business communications, including an awareness of requisites for international communications (languages, customs, time zones, currency and exchange rates).
8. Demonstrate writing/editing skills as follows:
   a. Write, proofread, and edit business correspondence.
   b. Use correct grammar, punctuation, capitalization, vocabulary and spelling.
   c. Select and use appropriate forms of technology for communication.
9. Exhibit a proficiency in the use of reference books.
10. Research, compose and orally present information for a variety of business situations utilizing appropriate technology.

E. Understand occupational safety issues, including avoidance of physical hazards.
   1. Discuss and implement good safety practices, including the following:
      a. personal
      b. lab
      c. fire
      d. electrical
      e. equipment
      f. tools
      g. interpretation of Material Safety Data Sheets (MSDSs)
      h. Environmental Protection Agency (EPA)
      i. Occupational Safety and Health Administration (OSHA)
      j. American Red Cross Standards (ARC)
      k. Networking Safety Standards
   2. Apply sound ergonomic principles in organizing one's work space.

F. Understand career paths and strategies for obtaining employment.
   1. Explore career opportunities and projected trends; investigate required education, training and experience; and develop an individual education plan.
   2. Identify steps for setting goals and writing personal goals and objectives.
   3. Examine aptitudes related to career options; relate personal characteristics and interests to educational and occupational opportunities.
   4. Develop a career portfolio, including the following documents:
      a. job application
      b. resume(s)
      c. appropriate cover and follow-up correspondence
   5. Identify and demonstrate effective interviewing techniques.

G. Understand and adapt to changing technology.
   1. Identify and explain how people, information, tools, machines, energy, capitol, physical space, and time influence the selection and use of networking technologies.
   2. Demonstrate the ability to use personal computers for loading and retrieving data, information gathering, measurements, and writing about and explaining computer networking.
   3. Identify the characteristics and explain the importance of adapting to changes, being flexible, and evaluating goals when working in the computer networking industry.
   4. Understand the importance of lifelong learning in adapting to changing technology.

H. Understand the importance of ethics in information technology fields.
   1. Discuss social and ethical responsibilities attached to access to information.
   2. Discuss rights to privacy of individuals with regard to information.
   3. Understand that copyright violations are theft.
   4. Discuss copyright laws and distinguish copyright violations in a variety of situations.
   5. Demonstrate ethical choices in workplace situations.
   6. Distinguish between first amendment freedoms and access to information.

Classroom Hours

II. SWITCHES 20

A. Demonstrate an understanding half-duplex Ethernet design.
   1. Define and apply RX (receive) and TX (transmit) method of transmission.
   2. Demonstrate the use of carrier sense multiple access/ collision detect (CSMA/CD) applications to collision detection.

B. Explain the concepts of congestion and bandwidth and their application to switched Ethernet LAN's.

C. Demonstrate the increase capabilities of applications when segmenting with LAN switches.
   1. Define switches application to larger files.
   2. Explain the OSI model level as it is applied when there is an increase in the number of files, users.
   3. Explain the function of a switch in propagation delay (latency).
   4. Summarize micro-segmentation as it relates to Ethernet transmission times.
   5. Explain how switches operate when dealing with distance and attenuation issues.

D. Design a plan to decrease latency with switches when repeaters are present.

E. Understand and define a full duplex Ethernet network.

F. Demonstrate the functions involved in analyzing bi-directional traffic, and understand collision-free traffic.

G. Explain the operation of a full duplex Ethernet and summarize the typical inherent problems associated with full operation.

H. Design a plan that improves LAN performance which illustrates the processes LAN switches use to learn addresses; include the following in the illustration or be able to explain and/or demonstrate the following concepts in the plan:
   1. segmenting
   2. segmenting steps
   3. dynamic steps

I. Using the concepts of segmentation and collision domains, solve a problem related to the low latency of LAN switches.

J. Recommend a method for applying the processes of segmenting using bridges to increased bandwidth.

K. Create a virtual circuit.

L. Define and describe the benefits of the following:
   1. switching
   2. symmetric switching
   3. asymmetric switching

Classroom Hours

M. Demonstrate the process of segmenting using bridges and the effect on the following:
   1. OSI model level
   2. operation
   3. increased latency
N. Define and demonstrate the function, operation, and types of memory buffer.
O. Explain and demonstrate segmenting using routers and the respective effect on the following:
   1. OSI model level
   2. function
   3. increased latency with routers operation
P. Compare and contrast the two types of memory buffer:
   1. port-based memory buffer
   2. shared memory buffer (dynamic)
Q. Compare and contrast the following switching methods; explain the advantages of the following:
   1. store and forward
   2. cut-through
R. Summarize spanning tree protocol, and explain the operation and function of spanning tree protocol as it involves the following:
   1. loops
   2. bridge protocol data units with STP advantages
S. Compare and contrast the advantages and disadvantages of using half-duplex Ethernet and full duplex Ethernet.
T. Recommend a solution to a problem that requires the application of either a half-duplex Ethernet or a full duplex Ethernet; defend the recommendation.

III. VIRTUAL LANs (VLANs) 20

A. Define and explain the functions and benefits of a VLAN.
B. Explain the uses of switches in VLANs.
C. Demonstrate reorganizing user locations in VLANs; explain the process used.
D. Describe the advantages of using a VLAN.
E. Set up a VLAN.
   1. Summarize the process used.
   2. Paraphrase the benefits.
F. Define and describe the operation of frame filtering by switches.
G. Define and explain the operation of firewall segmentation for broadcast.
H. Compare and contrast the advantages of using firewall segmentation for broadcast.
I. List and summarize the IEEE 802 VLAN standards.
J. Describe and discuss the operation and advantages of frame tagging.

Classroom Hours

K. Explain the benefits and operation of broadcast domains in VLANs.
L. Define and describe the process used to lower the number of broadcast storms.
M. Summarize the operation and benefits of using legacy hubs.
N. State a typical problem in which controlling the broadcast domain size is the solution; explain the solution.
O. Explain the operation of VLAN network security.
P. Describe and be able to identify the processes used to transport VLANs across backbones.
Q. Given a scenario in which VLANs are transported across backbones, describe how each of the following contribute transport:
    1. segmentation
    2. number of users
    3. access lists
R. Compare and contrast the initial configuration and configuration changes involved in the following:
    1. port-centric VLANs
    2. dynamic VLANs

IV. LAN DESIGN 20

A. Define and explain each of the LAN design goals of the following:
    1. functionality
    2. scalability
    3. adaptability
    4. manageability
B. Design a local area network and justify and/or document the decisions made about each of the following design characteristics:
    1. Design methodology.
    2. Analyze requirements and document.
    3. Identify and justify decisions concerning business issues.
    4. Identify and justify decisions concerning technology issues.
    5. Identify and justify decisions concerning administrative issues.
    6. Develop a LAN using both a star and extended star topology.
    7. Document the IP addressing scheme.
C. Set up a VLAN implementation plan.
    1. Gather and analyze network requirements.
    2. Analyze and document customer's LAN requirements.
    3. Write and state the customer's problem.
D. Design a network.

E. Describe and document the criteria used to address the following:
   1. speed
   2. expansion
F. Document the purpose and source of the devices chosen for layer two; specify and justify bridges and switches used.
G. Document the purpose and source of the devices chosen for layer three; specify and justify routers used.
H. Define and state the purpose and document server choice:
   1. enterprise
   2. workgroup
I. Documentation must include illustrations and justifications for the each of the following:
   1. physical layer(s)
   2. logical application
   3. addressing maps
   4. state and justify reasons for documentation
J. Explain path determination in network layer, and describe and identify the differences in router function and network layer function.
K. Compare and contrast network addresses and host addresses in network layer addressing.
L. Configure IGRP Protocols using the following:
   1. global tasks
   2. interface tasks
M. Demonstrate IGRP configuration tasks.
N. Define and summarize the purpose of routed versus routing protocols.
O. Demonstrate network layer protocol operation.
P. Do a multiprotocol routing.
Q. Define and explain the difference in operation of static versus dynamic protocol routing.
R. Demonstrate typology changes.
S. Define and conduct a dynamic routing operation, and identify, write, and document the resultant metrics changes.
T. Compare and contrast the various classes of routing protocols including the following:
   1. distance vector
   2. hybrid
   3. link state
U. Explain convergence and be able to define and document when it occurs.
V. Define and be able to identify and document when the following types of IP routing occurs:
   1. static routes
   2. default routes
   3. dynamic routing

Classroom Hours

W. Define and give the purpose and operational characteristics of the following:
   1. autonomous system
   2. internal/external routing protocol
   3. IGRP

X. Illustrate and explain composite metric.

V. ACCESS CONTROL LISTS 20

A. Define and describe the purpose and operation of the following:
   1. standard access lists
   2. extended access lists

B. Create a list of deny/permit tests; explain the difference.

C. Define and explain the function and operation of wildcard masks bits.

D. Create an access list that illustrates configuration commands including global statements and interface commands.

E. Summarize how to identify access lists.

F. Explain and conduct the processes involved for testing packs with access lists.

G. Create an IP access list using the following:
   1. wildcard mask bits
   2. wildcard any
   3. wildcard host

H. Configure IP with standard access.

I. Configure extending IP with access lists using named IP access list.

J. Document location of IP access list.

VI. NOVELL IPX 20

A. Explain the features of Cisco routers used in a Novell network.

B. Discuss the difference between Novell IPX and other networks.

C. Compare the features of Novell netware with known non-Novell netware.

D. Configure a Novell network using Novell IPX addresses.
   1. network number
   2. network node

E. Explain the process of determining IPX addresses.

F. Illustrate the operation of distance vector routing protocols.

G. Define and explain the purpose and the dynamic of SAP broadcast.

H. Name, define, and summarize Cisco encapsulation names.

I. Conduct a Novell RIP routing.

J. Configure a Novell IPX network using the following:
   1. global tasks
   2. interface tasks

Classroom Hours

K. Verify an IPX operation by monitoring the following: (document the monitoring activities)
   1. routing tables
   2. IPX servers
   3. IPX traffic

L. Troubleshoot an Novell network documenting the following:
   1. IPX routing
   2. IPX SAP

VII. WIDE AREA NETWORKS (WAN) 20

A. Understand the basics of WANs including common WAN technologies, types of wide area services, encapsulation formats, and link options.
   1. Understand and describe the purpose of WANs.
   2. Describe the various WAN devices.
   3. Understand and be able to apply the standards in WANs.
   4. Understand and apply WAN operation at the physical layer.
   5. Understand and apply WAN operation at the data link layer.
   6. Understand and interface with WAN service providers.
   7. Understand using WAN services with routers.
   8. Understand WAN encapsulation formats, including the following:
      a. protocols
      b. serial line encapsulation
      c. high-level data link control (HDLC)
      d. point-to-point protocol (PPP)

B. Understand WAN link options, including the following:
   1. standards/capacities
   2. dedicated
   3. switched
   4. dial on demand

C. Understand the process and considerations for designing a hierarchical model of a WAN.
   1. Understand the process for gathering data about the needs of the user; gather user data.
   2. Understand the benefits of using a hierarchical design model.
   3. Understand the three layers of the hierarchical model and their functions.
   4. Describe placement of integrated services data network (ISDN) and frame relay.
   5. Understand the impact on traffic of placement of the enterprise and workgroup servers.

D. Design a hierarchical WAN model.

E. Implement a hierarchical WAN model.

		Classroom Hours	CC/CVE Hours
VIII.	POINT-TO-POINT PROTOCOL (PPP)	10	
	A. Understand the components, process, and operation of PPP communication.		
	1. Understand the basic components defining PPP communication.		
	2. Describe PPP's connection negotiation process.		
	3. Understand the use of link control protocol (LCP) and network control protocol (NCP) frames in PPP.		
	B. Understand the process for configuring and verifying PPP.		
	1. Negotiate a PPP connection.		
	2. Configure and verify a PPP connection.		
IX.	INTEGRATED SERVICES DIGITAL NETWORK (ISDN)	10	
	A. Understand the services, standards, components, operation, and configuration of ISDN communication.		
	1. Understand and articulate why ISDN is used.		
	2. Understand and be able to describe the special services offered by ISDN communication.		
	3. Understand and apply the standards of ISDN.		
	4. Understand the components of ISDN.		
	5. Understand the operation of ISDN.		
	6. Understand the process for configuring and verifying ISDN.		
	B. Configure and verify an ISDN connection.		
X.	FRAME RELAY	10	
	A. Understand the services, standards, components, operation, and configuration of frame relay communication.		
	1. Understand and use the basic devices of frame relay.		
	2. Understand the functions of data-link connection identifier (DLCI) in frame relay.		
	3. Understand the operation of frame relay.		
	4. Understand the issue of split horizon.		
	5. Understand sub-interface.		
	6. Understand how frame relay uses sub-interfaces to solve the problem of split horizon.		
	7. Understand the process for configuring and verifying frame relay on router interfaces.		
	8. Understand the process for configuring frame relay sub-interfaces.		
	B. Configure a frame relay using the following:		
	1. sub-interfaces		
	2. DLCI functions		
XI.	WORK-BASED LEARNING Apply information technology skills in workplace settings.		240
	TOTAL HOURS	180	240